Deutsches Institut für Wirtschaftsforschung

DIW BERLIN

Discussion Papers

934

Frank M. Fossen • Daniela Glocker

Expected Future Earnings, Taxation, and University Enrollment: A Microeconometric Model with Uncertainty

Berlin, October 2009

Opinions expressed in this paper are those of the author and do not necessarily reflect views of the institute.

IMPRESSUM

© DIW Berlin, 2009

DIW Berlin
German Institute for Economic Research
Mohrenstr. 58
10117 Berlin
Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
http://www.diw.de

ISSN print edition 1433-0210
ISSN electronic edition 1619-4535

Available for free downloading from the DIW Berlin website.

Discussion Papers of DIW Berlin are indexed in RePEc and SSRN.
Papers can be downloaded free of charge from the following websites:

http://www.diw.de/english/products/publications/discussion_papers/27539.html
http://ideas.repec.org/s/diw/diwwpp.html
http://papers.ssrn.com/sol3/JELJOUR_Results.cfm?form_name=journalbrowse&journal_id=1079991

Expected Future Earnings, Taxation, and University Enrollment: A Microeconometric Model with Uncertainty*

Frank M. Fossen† Daniela Glocker‡

DIW Berlin

October 2009

Abstract

Taxation changes the expectations of prospective university students about their future level and uncertainty of after-tax income. To estimate the impact of taxes on university enrollment, we develop and estimate a structural microeconometric model, in which a high-school graduate decides to enter university studies if expected lifetime utility from this choice is greater than that anticipated from starting to work right away. We estimate the ex-ante future paths of the expectation and variance of net income for German high-school graduates, using only information available to those graduates at the time of the enrollment decision, accounting for multiple non-random selection and employing a microsimulation model to account for taxation. In addition to income uncertainty, the enrollment model takes into account university dropout and unemployment risks, as well as potential credit constraints. The estimation results are consistent with expectations. First, higher risk-adjusted returns to an academic education increase the probability of university enrollment. Second, high-school graduates are moderately risk averse, as indicated by the Arrow-Pratt coefficient of risk aversion estimated within the model. Thus, higher uncertainty among academics decreases enrollment rates. A simulation based on the estimated structural model indicates that a revenue-neutral, flat-rate tax reform with an unchanged basic tax allowance would increase enrollment rates for men in Germany because of the higher expected net income in the higher income range.

Keywords: University Enrollment, Income Taxation, Flat Tax, Income Risk, Risk Aversion
JEL: H24, I20, I28.

*We thank Viktor Steiner and participants of the Economic Policy Seminar, which is held jointly by the DIW Berlin and the Freie Universität Berlin, for helpful comments. Financial support by the German Science Foundation (DFG) under the project STE 681/6-2 is gratefully acknowledged. The usual disclaimer applies.

†German Institut for Economic Research (DIW Berlin), 10108 Berlin, Germany, ffossen@diw.de.

‡German Institut for Economic Research (DIW Berlin), 10108 Berlin, Germany, dglocker@diw.de.

1 Introduction

When high-school graduates decide between enrolling in a university and starting to work right away, they likely consider both the returns to a higher education and income uncertainty associated with both alternatives. Consequently, taxation should be expected to play a role in the university enrollment decision, in that it influences both net income levels and risk.

To estimate the impact of tax policy on enrollment rates, we develop and estimate a structural microeconometric model of the university enrollment decision. A high-school graduate chooses to study if her expected lifetime utility from an academic career exceeds that anticipated from an alternative career. Utility in this model therefore depends on the ex-ante expectation and variance of net income; we estimate both values for each high-school graduate for the two alternative career paths, based on information available at the time of the enrollment decision. This approach avoids a reliance on ex-post income realizations to explain education decisions, as in some prior literature, which has prompted some criticisms (Cunha et al., 2005; Cunha and Heckman, 2007). We take into account non-random selection based on multiple correlated criteria. The structural parameters that we estimate include the Arrow-Pratt coefficient of constant relative risk aversion.

Germany provides an interesting context in which to study the interaction of taxes and university enrollment, because the enrollment rates in Germany are considerably lower than those in other developed countries, and the environment is marked by comparably high and progressive taxes. According to the OECD (2008), 35% of young Germans will enter tertiary education (university or university of applied science), compared with an OECD-average of 56%.[1] Are the low enrollment rates a consequence of too low after-tax returns to education and an income risk which is still considerably high?

In contrast with the existing literature on education and income uncertainty, we explicitly model taxation by integrating a microsimulation model of the German tax and

[1]No standardized system for job qualification exists in the OECD countries, so the same job may demand a different form of training (e.g., apprenticeship, university degree) in different countries, thus these numbers should be interpreted with care.

social security legislation. After having estimated the structural model of university enrollment, this allows us to simulate the effect of changes in the tax policy on the decision to take up higher education.

Although the focus of this study is income risk, we also include two other important sources of risk in the model: the risk of dropping out of university, and unemployment risk, which is much higher for non-academics in Germany. Furthermore, we control for the possibility that would-be university students may face credit constraints by including information about their financial and social backgrounds. To conduct our analysis, we use a large, representative, panel data survey, the German Socio-Economic Panel Study (SOEP), which not only provides detailed information on the working-age population, but also on financial resources, social background, and high-school achievements of high-school graduates.

The results from the estimation of our proposed enrollment model are consistent with expectations: Higher expected risk-adjusted returns from an academic career path in comparison with a non-academic career path increase high-school graduates' probability of enrolling in a university. Furthermore, young people are moderately risk averse when deciding to enroll in higher education. Consequently, higher income risk associated with an academic career path discourages potential students from enrolling.

We also apply the estimated microeconometric model to simulate the effects of two hypothetical flat-rate tax reform scenarios on enrollment rates in Germany. The simulation results indicate that a revenue-neutral flat tax scenario with an unchanged basic tax allowance would significantly increase the cumulative probability of university enrollment for male high-school graduates by 1.8 percentage points (five years after their high-school graduation), which corresponds to a relative increase of 3.1%. The incentive effect, which arises because a flat tax increases the expected net income of academics with higher income, outweighs the reduced insurance effect, which is caused by an increase of the net income variance. Because of their lower expected wages, the incentive effect of the revenue-neutral flat tax is weaker for women. Consequently, the flat tax scenario with an unchanged basic allowance would not have a significant effect on the cumulative enrollment probability of female high-school graduates.

Heckman et al. (1998) analyze the effect of similar policies on human capital accumulation in the United States but without considering wage risk. They find that switching from a progressive tax legislation to a flat tax system increases college attendance, an effect they ascribe to the lower marginal tax rate for higher income in a flat tax scenario compared with a progressive tax system. Recent theoretical literature on income taxation and education also notes the role of wage uncertainty. For example, Hogan and Walker (2003), Anderberg and Andersson (2003), and Anderberg (2009) develop models of education and public policy, including tax policy, which as a key feature consider that education may change the wage risk. To the best of our knowledge though, this paper represents the first empirical study of taxation, wage risk, and education.

Literature pertaining to the effect of uncertainty on the decision to pursue a tertiary education, without an explicit consideration of taxes, dates back to Levhari and Weiss (1974). They introduce a two-period model, where in the first period the choice between getting schooling or going to work is made, and in period 2 there is only work. The payoff for time spent in school is ex-ante uncertain but revealed at the beginning of the second period. These authors find that increasing risk, i.e. the variance in the payoff for education, reduces investments in education. Subsequent studies by Eaton and Rosen (1980) and Kodde (1986) build on this model and similarly conclude that uncertainty is a main determinant of the decision to invest in education. Hartog and Serrano (2007) analyze the effect of stochastic post-school earnings on the desired length of schooling and find that greater post-schooling earnings risk requires higher expected returns. Explicitly modeling the choice for college enrollment, Carneiro et al. (2003) reanalyze a model introduced by Willis and Rosen (1979) by accounting for uncertainty in the returns to education. They reveal that reducing uncertainty in returns increases college enrollment. Although these models differ somewhat in their conceptualization of risk, they all essentially consider the effect of changes in the variance of the post-school wages and find that more risk in the returns reduces the investment.

A related stream of literature investigates the strong correlation of higher education with parental income. One explanation posits that the possible presence of credit constraints, such as in form of short-run liquidity constraints, prevents children from a poor financial background from covering the expenses of higher education (e.g., Shea, 2000; Kane, 2003). Other studies argue that it is not credit constraints but rather other factors, partly captured by measures of credit constraints (e.g., parental income and education), that determine university enrollment (Carneiro and Heckman, 2002; Keane and Wolpin, 2001). They assert that it is the effect of long-term factors that may promote cognitive and noncognitive ability of students, such as parental time or the purchase of market goods that are complementary to learning, that promote academic success in school and ultimately university enrollment. An ongoing political debate also stresses the importance of credit constraints as a possible explanation for low university enrollment rates. Therefore, most policies designed to increase enrollment work to overcome credit constraints such as through student aid programs.

The remainder of this article is structured as follows: In Section 2, we introduce our model for the university enrollment decision, followed by a description of the data in Section 3. Section 4 describes the wage and variance estimation, before we describe the econometrically estimated results of the structural enrollment model in Section 5. In Section 6, we present the simulation results for the flat-rate tax scenarios, then conclude in Section 7.

2 Modeling the University Enrollment Decision

The university enrollment decision can be modeled econometrically in a discrete time hazard rate framework. The sample 'at risk of enrollment' consists of high-school graduates who left school with a university entrance qualification (Abitur or Fachabitur)[2], have not

[2] In Germany, leaving high school with the degree Abitur (or Fachabitur) is the only means to qualify for enrollment at a university (or university of applied science, respectively). In the following, we do not distinguish between general universities and universities of applied science.

yet started studying, and are between 18 and 25 years of age, which is the usual age range for university enrollment in Germany. We model spells in yearly steps, such that the enrollment decision is made every year. A hazard rate model has the advantage of consistently taking into account censored spells, which refer to people not fully observed in the relevant period of their lives.[3]

We establish the model as follows: After obtaining an Abitur or Fachabitur, a high-school graduate rationally chooses to enroll at a university to pursue an academic career or to start working right away. In the latter case it is assumed she will first take an apprenticeship, if she has not already finished one. Our model captures the choice of 97% of all German high-school graduates, because only 3% choose to neither go to college nor take up an apprenticeship (see Heine et al., 2008). When making the decision between studying and working, a person is forward looking, i.e. she calculates her future utility gains of a university degree. Individual i in observation year t decides to undertake tertiary education ($\delta_{it} = 1$) if the expected utility of lifetime earnings is higher with a university degree (lifetime utility V_{1it}) than without (lifetime utility V_{2it}):

$$\delta_{it} = \begin{cases} 1, & \text{if} \quad E(V_{1it}) > E(V_{2it}). \\ 0, & \text{otherwise.} \end{cases} \tag{1}$$

Lifetime utility V_{sit} in both states $s \in \{1; 2\}$ depends on the discounted sum of the period-specific utilities $U(y_{si\tau})$ in each future period τ over the lifecycle, which are determined by future income $y_{si\tau}$, which is ex-ante forecasted by the high-school graduate. In addition, V_{sit} is a function of the current characteristics x_{it} of the high-school graduate at the time of the enrollment decision as well as of the duration since her high-school graduation d_{it}. These variables may shift tastes or costs with respect to university enrollment. The

[3]Left-censored spells can be taken into account consistently, because retrospective biographical data reveal the spell duration.

lifetime utility thus can be written as

$$V_{sit} = \sum_{\tau=0}^{T} \frac{1}{\gamma^{\tau}} U(y_{si\tau}) + x_{it}'\beta_1 + \varphi_s(d_{it}) + \epsilon_{sit}, \tag{2}$$

where $\varphi_s(d_{it})$ is a function of the duration since graduation (baseline hazard)[4], $\gamma > 1$ is the time discount factor for utility, and ϵ_{sit} captures preferences for enrollment known to the members in the sample but unobservable to the researcher, such that they are treated as a random variable.

We also recognize $y_{1i\tau}$ and $y_{2i\tau}$ as random variables from the perspectives of both the high-school graduates and the researcher, because future income is uncertain. In this model, we assume that people know the probability distribution of their future income for both career options but not the future realizations.

The vector x_{it} notably controls for credit constraints, specifically, student aid eligibility to directly control for credit constraints, and parental education and parental net income to capture long- and short-term credit constraints indirectly. We simulate the eligibility of a high-school graduate for student aid, according to German legislation, by taking her financial resources into account. If a potential student cannot cover at least her living expenses by drawing money from her own wealth or through support from her parents, she is eligible for student aid. In addition, x_{it} includes the age at which the person finished high school, whether she has no, one, or more than one siblings, if she has finished an apprenticeship, her high school grades in math and German, and her individual intention to pursue a university degree at age 17 years. Furthermore, the explanatory variables include gender, regional, and time dummies.

Beyond income risk, we assume that high-school graduates are aware of the risks of unemployment and dropping out of the university. Unemployment risk varies by state s. When unemployed, a person receives unemployment benefits at the unemployment benefit rate (UBR) set at 60% (67% for parents) of the net wage the person would

[4] In the estimation, $\varphi_s(d_{it})$ is specified flexibly by dummy variables that capture the time since high-school graduation.

otherwise receive. This value represents a moderately simplified model of the German legislation for temporary unemployment.[5] The assumption is that agents expect potential unemployment to last no longer than the period during which the unemployment benefit can be received, usually one year.[6] Drawing on figures reported in Hummel and Reinberg (2007), we assume university graduates in Germany face a yearly unemployment risk of $risk_1^u = 4\%$, whereas those without a university degree have a higher risk of $risk_2^u = 9\%$. Taking unemployment risk into account reduces expected wages in both alternatives, but more so for the non-academic career path because of the higher unemployment risk. Income adjusted for the risk of unemployment (y^u) then can be written as:

$$y_{si\tau}^u = ((1 - risk_s^u) + risk_s^u UBR) y_{si\tau}. \tag{3}$$

The risk of not finishing the university successfully can be modeled as follows: A student who drops out suffers a deduction from the gross income she would receive as a successful university graduate. The dropout risk in Germany is assumed to be $risk_1^d = 18\%$ (estimated by Glocker, 2009), accompanied by a wage reduction of $\psi = 21\%$ of gross income (see Heublein et al., 2003). A university dropout thus receives adjusted income $y_{1i\tau}^{ud} = (1-\psi) * y_{1i\tau}^u$. For the non-academic career path, $risk_2^d = 0\%$. While unemployment is modeled as an independent year-to-year risk, the dropout risk refers to an entire lifetime income path.

Accounting for unemployment and dropout risk, equation 2 becomes

$$\begin{aligned} V_{sit} &= (1 - risk_s^d) \sum_{\tau=0}^{T} \frac{1}{\gamma^\tau} U(y_{si\tau}^u) + risk_s^d \sum_{\tau=0}^{T} \frac{1}{\gamma^\tau} U(y_{si\tau}^{ud}) \\ &\quad + x_{it}' \beta_s + \varphi_s(d_{it}) + \varepsilon_{sit}. \end{aligned} \tag{4}$$

To evaluate this equation further, we have to take the expectation with respect to the

[5] Unemployment benefits in Germany (Arbeitslosengeld I) depend on the last net wage of an unemployed person, where net wage is calculated using a lump sum social security contribution rate.

[6] Shorter periods of benefit entitlement apply to people who previously have not contributed to unemployment insurance for a sufficient number of months, whereas longer periods are available for older people with a sufficient contribution record.

random variables $y_{si\tau}$:

$$\begin{aligned} E(V_{sit}) &= (1-risk_s^d)\sum_{\tau=0}^{T}\frac{1}{\gamma^\tau}E_\tau\left[U(y_{si\tau}^u)\right] + risk_s^d\sum_{\tau=0}^{T}\frac{1}{\gamma^\tau}E_\tau\left[U(y_{si\tau}^{ud})\right] \\ &\quad + x_{it}'\beta_s + \varphi_s(d_{it}) + \varepsilon_{sit}. \end{aligned} \tag{5}$$

The expectation of $U(y_{si\tau})$ can be approximated by a second-order Taylor series expansion around $\mu_{si\tau} = E(y_{si\tau})$:

$$\begin{aligned} E(U(y_{si\tau})) &\approx U(\mu_{si\tau}) + U'(\mu_{si\tau})E(y_{si\tau}-\mu_{si\tau}) + \frac{1}{2}U''(\mu_{si\tau})E((y_{si\tau}-\mu_{si\tau})^2) \\ &= U(\mu_{si\tau}) + \frac{1}{2}U''(\mu_{si\tau})\sigma_{si\tau}^2, \end{aligned} \tag{6}$$

where $\sigma_{si\tau}^2 = Var(y_{si\tau})$. We must specify a functional form for $U(.)$. In the following, we assume a constant relative risk aversion (CRRA), as in Hartog and Vijverberg (2007), which implies that the utility function must satisfy

$$-\frac{yU''(y)}{U'(y)} = \rho, \tag{7}$$

where the parameter ρ is the coefficient of CRRA (Pratt, 1964).[7] The utility function we choose satisfies the CRRA condition and is increasing in the money ($U'(y_{si\tau}) > 0$):

$$U(y_{si\tau}) = \begin{cases} \alpha\frac{y_{si\tau}^{1-\rho}}{1-\rho}, & \text{if } \rho \neq 1. \\ \alpha \ln y_{si\tau}, & \text{if } \rho = 1. \end{cases} \tag{8}$$

This specification therefore implies a risk preference for $\rho < 0$, risk neutrality for $\rho = 0$, and risk aversion for $\rho > 0$. The structural risk preference parameter ρ will be estimated econometrically, along with the coefficients of risk-adjusted income α and the control variables using the maximum likelihood method.

[7] Alternatively we could assume constant absolute risk aversion (CARA). The advantage of the CARA utility is that a closed-form representation of expected utility exists if y is normally distributed, and no Taylor approximation is needed. Prior literature prefers CRRA though as the more realistic specification, as exemplified by Keane and Wolpin (2001), Sauer (2004), Belzil and Hansen (2004), and Brodaty et al. (2006).

Plugging $U(.)$ and its second derivative into the Taylor approximation (equation 6) enables us to evaluate equation 5:

$$E(V_{sit}) = \alpha W_{sit} + x'_{it}\beta_s + \varphi_s(d_{it}) + \varepsilon_{sit}, \tag{9}$$

where W_{sit} is defined as follows ($\rho \neq 1$):[8]

$$W_{sit} = (1 - risk_s^d)\sum_{\tau=0}^{T}\frac{1}{\gamma^\tau}\left(\frac{\mu_{usi\tau}^{1-\rho}}{1-\rho} - \frac{1}{2}\rho\mu_{usi\tau}^{-\rho-1}\sigma_{usi\tau}^2\right) + risk_s^d\sum_{\tau=0}^{T}\frac{1}{\gamma^\tau}\left(\frac{\mu_{udsi\tau}^{1-\rho}}{1-\rho} - \frac{1}{2}\rho\mu_{udsi\tau}^{-\rho-1}\sigma_{udsi\tau}^2\right). \tag{10}$$

The parameter $\alpha > 0$ reflects the weight of the risk-adjusted income in the enrollment decision. For $\alpha > 0$ and $\mu_{si\tau} > 0$, the equation implies that for risk-averse agents, expected lifetime utility decreases with greater variance of income, whereas for risk-neutral agents, the variance does not matter.

Referring back to equation 1, the probability of enrolling in higher education equals:

$$P(\delta_{it} = 1) = P(E(V_1) > E(V_2)) = F(\alpha(W_{1it} - W_{2it}) + x'_{it}\beta + \varphi(d_{it})), \tag{11}$$

where $\beta = \beta_1 - \beta_2$, and F is the cumulative distribution function of the error difference $\varepsilon_{2it} - \varepsilon_{1it}$. The likelihood function therefore can be written as:

$$\begin{aligned} L = \ & \textstyle\prod_{i=1}^{N}\prod_{t\in T_i} F(\alpha(W_{1it} - W_{2it}) + x'_{it}\beta + \varphi(d_{it}))^{\delta_{it}} \\ & \times (1 - F(\alpha(W_{1it} - W_{2it}) + x'_{it}\beta + \varphi(d_{it})))^{(1-\delta_{it})}, \end{aligned} \tag{12}$$

where T_i is the set of years in which individual i is observed.

To estimate the model, we next need to specify the cumulative distribution function of the error difference F. Following McFadden's (1974) random utility model, we assume that the error terms ε_{sit} are type-I extreme value distributed and i.i.d.. As McFadden

[8] When $\rho = 1$, W_{sit} can be written as:

$$W_{sit} = (1 - risk_s^d)\sum_{\tau=0}^{T}\frac{1}{\gamma^\tau}\left(\ln\mu_{usi\tau} - \frac{1}{2\mu_{usi\tau}^2}\sigma_{usi\tau}^2\right) + risk_s^d\sum_{\tau=0}^{T}\frac{1}{\gamma^\tau}\left(\ln\mu_{udsi\tau} - \frac{1}{2\mu_{udsi\tau}^2}\sigma_{udsi\tau}^2\right).$$

shows, F is therefore the cumulative logistic probability distribution function.

To predict the future wages, we make several additional assumptions about the two different career paths. The first assumption relates to income while studying at a university. We assume that it takes five years to graduate, which is the approximate mean in Germany. Because students generally receive monetary transfers, whether from their parents or as student aid from the government, assuming no income during university attendance would be unrealistic. Instead, we assume that these transfers equal the officially announced minimum cost of living, which each student is entitled to receive according to German legislation. During the observation period, these costs were 565 EUR per month (e.g., Deutscher Bundestag, 2007). We distinguish between students who receive this income from their own or their parents' wealth and students who rely on student aid. Although the amount of income remains the same, transfers from parents versus student aid are subject to different repayment rules. We therefore assume no repayments if the income is drawn from the students' own or their parents' wealth, whereas students who draw money from student aid must consider repayment obligations when calculating their expected lifetime utility. The German Federal Training Assistance Scheme states that half of the amount of student aid received must be repaid (interest free) as soon as the borrower's monthly net income exceeds 1040 EUR. The other half is a subsidy. We model the eligibility and repayment rules for student aid accordingly. Furthermore, we realize that many university students work in some kind of part-time job. As university students already "work" full-time on their education and additional moonlighting further reduces leasure time, we assume the additional utility from this moonlighting is small and can be neglected when comparing lifetime utility between the academic and non-academic career paths.

3 Data

This analysis is based on the German Socio-Economic Panel (SOEP) which is provided by the German Institute for Economic Research (DIW Berlin). The SOEP is a representative yearly panel survey that gathers detailed information about the socio-economic situation of (currently) more than 21,000 persons living in approximately 12,000 households in Germany. Wagner et al. (2007) provide a detailed description of the SOEP. This analysis draws on the most recent waves (2002 to 2007[9]). One of the advantages of the SOEP is that in addition to the information collected in the annual interviews, it provides retrospective information about the respondents' youth and socialization period, such as school grades, which are important control variables in the university enrollment model.

We estimate the university enrollment model for the subsample of secondary school graduates who have obtained a university admission qualification (Abitur/Fachabitur) and are between 18 and 25 years of age (1,144 observations). Table B1 in the Appendix lists the descriptive statistics about these potential university entrants, and Table B2 shows descriptive statistics for the full sample used to estimate earnings. We estimate level and variance of wages separately for men and women because of the well-documented differences in male and female wage equations. All monetary variables, and therefore all monetary results, are deflated by the Consumer Price Index (2000 = 100).

4 Estimation of Expectation and Variance of Earnings

The first step in our analysis of the enrollment decision is to predict individual wage profiles and the variance of wages over lifetime in the alternative states, with and without university degrees. In this section, we present the wage and variance estimations, which are based on the full sample of working-age people.

4.1 Selection

To control for selection effects in the earnings regressions, we apply the Heckman-Lee method of estimating simultaneous equations with multiple sample selection. The first

[9]The 2007 wave is used to obtain retrospective income information for 2006 only.

selection equation is based on each person's educational attainment, since we want to estimate wages separately for academic and non-academic careers. The second selection occurs because we only observe wages for people who are working. Ignoring these two selection processes would lead to a selectivity bias in the wage equation (e.g. Fishe et al., 1981). The first selection equation captures the individual choice to be a university graduate:

$$I_{1it}^* = z_{1it}\eta_1 + v_{1it}, \tag{13}$$

with

$$I_{1it} = \begin{cases} 1, & \text{if} \quad I_{1it}^* > 0. \\ 0, & \text{else.} \end{cases} \tag{14}$$

The second selection equation models the person's decision to work:

$$I_{2it}^* = z_{2it}\eta_2 + I_{1it}\iota + v_{2it}, \tag{15}$$

with

$$I_{2it} = \begin{cases} 1, & \text{if} \quad I_{2it}^* > 0, \\ 0, & \text{else.} \end{cases} \tag{16}$$

The vector z_{1it} includes only information that is available to the person at the time of the enrollment decision, such as most recent high-school grades in German and math, the degree to which parents showed interest in the graduate's school performance, size of the city in which the person grew up, parents' high-school degree and employment status, and whether the parents were born in Germany. The vector z_{2it} in the work participation equations features relevant contemporaneous information: age and unemployment experience (level and square terms), region, education, unemployment rate in the region, year fixed effects, and whether the individual is married, has young children, was born in Germany, or is physically handicapped.

We allow the two selection processes to correlate, as is reflected in the error terms

$(cov(v_{1it}, v_{2it}) = \rho_{v_{1it}v_{2it}} \neq 0)$.

We estimate the selection equation using a bivariate probit (Maddala, 1986) and allow for a structural shift by including the outcome of the first selection process, university education, as a dummy variable in the second step (Heckman, 1978), with coefficient ι. Appendix A describes the method. The estimated parameters $\hat{\eta}_1$, $\hat{\eta}_2$, and $\hat{\rho}_{v_1v_2}$ then can be used to calculate selection correction terms for the wage equations for academic and non-academic careers as follows (neglecting individual and time indices):

Academic	Non-Academic
$M_{ab} = (1-\rho^2_{v_1v_2})^{-1}(P_a - \rho_{v_1v_2}P_b)$,	$M_{cd} = (1-\rho^2_{v_1v_2})^{-1}(P_c - \rho_{v_1v_2}P_d)$,
with	
$a, b = 1, 2$ and $a \neq b$,	$c, d = 3, 4$ and $c \neq d$,
where	
$P_1 = \frac{\int_{-(z_2\eta_2+I_1\iota)}^{\infty}\int_{-z_1\eta_1}^{\infty} v_1 f(v_1v_2)dv_1dv_2}{F(-z_1\eta_1, -(z_2\eta_2+I_1\iota), \rho)}$	$P_3 = \frac{\int_{-(z_2\eta_2+I_1\iota)}^{\infty}\int_{-\infty}^{-z_1\eta_1} v_1 f(v_1v_2)dv_1dv_2}{F(z_1\eta_1, -(z_2\eta_2+I_1\iota), -\rho)}$
$P_2 = \frac{\int_{-z_1\eta_1}^{\infty}\int_{-(z_2\eta_2+I_1\iota)}^{\infty} v_2 f(v_1v_2)dv_2dv_1}{F(-z_1\eta_1, -(z_2\eta_2+I_1\iota), \rho)}$	$P_4 = \frac{\int_{-\infty}^{-z_1\eta_1}\int_{-(z_2\eta_2+I_1\iota)}^{\infty} v_2 f(v_1v_2)dv_2dv_1}{F(z_1\eta_1, -(z_2\eta_2+I_1\iota), -\rho)}$.

Table B3 in the Appendix shows the estimation results for the bivariate probit estimations, separately for men and women. For each gender, the results in the first column refer to the probability of earning a university degree (being an academic), and the second column indicates the probability of working. The estimated value of $\rho_{v_1v_2}$ is positive and significant for men, which suggests a positive correlation between education and work decisions, though this correlation is insignificant for women. As expected, better grades in secondary school increase the probability of earning a university degree. Having small children decreases the probability of work participation for women.

4.2 Estimation of Expected Wages

For each person in the sample, we must estimate expected net wages for careers with and without a university degree. Separately for the two subsamples of academics $(s = 1)$

and non-academics ($s = 2$), we regress the hourly gross wages[10] (y^g_{sit}) on a vector of demographic and human capital and work-related variables z^{wage}_{it}:

$$\begin{aligned} y^g_{1it} &= \theta'_1 z^{wage}_{it} + \lambda_{11} M_{12it} + \lambda_{12} M_{21it} + u_{1it}, \textit{ and} \\ y^g_{2it} &= \theta'_2 z^{wage}_{it} + \lambda_{21} M_{34it} + \lambda_{22} M_{43it} + u_{2it}, \end{aligned} \tag{17}$$

where θ_s is the coefficient vector, the term $\lambda_{s1} M_{xy} + \lambda_{s2} M_{yx}$ controls for selection (as discussed previously), and u_{sit} is the error term. Conceptually, human capital variables clearly determine gross, but not net, wages, because the latter depend on the tax legislation. Thus, we estimate gross wages here and derive net wages subsequently (see Section 4.5). The variable vector z^{wage}_{it} includes work experience (in years, as level, and squared), year dummies, 15 federal state dummies, 9 industry dummies, and dummies indicating self-employment, a completed apprenticeship, and current service in an apprenticeship, as well as German nationality, physical handicap, and an intercept.

Table B4 in the Appendix provides the estimation results of the wage equations for academics and non-academics, separately for men and women. Wages increase with work experience, reflecting the typical profile. In all earnings regressions, at least one of the selection terms is significantly different from 0; that is, that non-random selection is relevant for the wage estimations.

4.3 Estimation of Variance of Wages

In addition to the expectation, we require the variance of wages to estimate the enrollment model. To estimate this variance, we use flexible heteroscedasticity functions of the residual variance from the wage equations. Specifically, the natural logarithms of the squared residuals from the wage regressions are regressed on the explanatory variables of the earnings model z^{wage}_{it} and the selection terms M_{ab} and M_{cd} to control for selection,

[10] Wages in year t are obtained from retrospective questions in wave $t+1$ about a respondent's monthly gross income in t, divided by the actual number of hours worked in the month before the interview in t.

separately for academics and non-academics:

$$\begin{aligned}\ln(\hat{u}_{1it}^2) &= \pi_1' z_{it}^{wage} + \lambda_{11} M_{12it} + \lambda_{12} M_{21it} + e_{1it},\ and \\ \ln(\hat{u}_{2it}^2) &= \pi_2' z_{it}^{wage} + \lambda_{21} M_{34it} + \lambda_{22} M_{43it} + e_{2it},\end{aligned} \tag{18}$$

where e_{sit} is the error term.[11] In contrast with the estimation of a population parameter, this approach allows the predicted second moment of wages to vary not only between academics and non-academics but also with individual characteristics and covariates, just like the predicted first moment.

The results of the variance estimation for academic and non-academic men and women appear in Table B5 in the Appendix. The explanatory variables are jointly significant in each of the four estimations, which confirms the hypothesis that wages are heteroskedastic (Breusch-Pagan test). For academic men, as well as for non-academic women, some of the selection terms are significantly different from zero, but none of them are for non-academic men or academic women.

4.4 Forecasting Wage Profiles

For each observation in the sample of high-school graduates, we use the estimated wage and variance equations to forecast individual profiles of the expected value and the variance of their wages over the lifecycle, separately for the two alternatives of an academic versus a non-academic career path. This step is required because the full profiles enter the decision model of university enrollment. For the academic career path, the first five years are assumed to be spent at the university, and students are assumed to receive monetary transfers from their parents or student aid (see Section 2). In the sixth year, the university graduate is assumed to start working, and work experience is increased successively to forecast the complete wage profile. In the non-academic career path, people are

[11] To obtain consistent predictions for the squared residuals, the predicted values from the log model must be exponentiated and multiplied by the expected value of $\exp(e_{sit})$. A consistent estimate for the expected value of $\exp(e_{sit})$ can be obtained from a regression of the squared residuals on the exponentiated predicted values from the log model through the origin. This procedure does not require normality of e_{sit}.

assumed to start working right away, and work experience is increased from the first year on. We assume that those who have not yet finished an apprenticeship plan to pursue an apprenticeship during the first two years of their non-academic career path. In the wage and variance equations, we capture lower wages during the apprenticeship with a dummy variable indicating that someone is currently an apprentice (This variable is negative and significant in the wage equation; see Table B4). After two years, we assume the apprenticeship is finished. When forecasting the wage profiles, in addition to increasing each person's work experience and adjusting the information about apprenticeships, we assign the marital status and number of children information, as well as industry sectors and self-employment, according to the aggregate distributions, conditional on age and gender. The end of the individual time horizon occurs at the age of 65 years, the legal retirement age in Germany during the observation period.

4.5 Microsimulation Model of Income Taxation

Because individual utility depends on net (after-tax) income, the relevant variables in the enrollment model refer to the expected value and the variance of net wages. To derive the net from the gross wages, we use a microsimulation model of the German income tax and social security system. Based on a taxpayer's gross income, age, region of residence (there are some regional specifics in the relevant laws), and the legislation in the year of observation, the tax model calculates the income tax according to the progressive German income tax schedule, the solidarity surcharge, the social security contributions (i.e., contributions to statutory pension, health, long-term care, and unemployment insurance), and finally net income.[12] The flat tax reform scenarios can be simulated by changing the parameters of the income tax schedule.

Because we predict gross incomes for the future of current high-school graduates, the household context (marital status, spouse's income, number of children) and other relevant

[12] We convert estimated real hourly gross wages into nominal yearly gross earnings for these calculations, and the resulting nominal yearly net earnings are converted back to real hourly net wages, using the average number of hours worked in the sample and the Consumer Price Index.

information, such as extraordinary future expenses at the time when gross incomes will be earned and taxed, are unknown. In this respect, this application of microsimulation differs from others where the full information available in a dataset about the actual current household context, incomes, and expenses, can be used for a full household-specific tax-benefit simulation, as in the tax-benefit model STSM (Steiner et al., 2008). Here, instead, for simplicity, we assume that the net incomes are calculated for an unmarried person without children, who does not receive one-off payments and does not pay church tax. The assumption of being unmarried has the same tax implications as the assumption of being married to a spouse at the same income level. Net income is then derived exactly equal to the net income paid to an employee after the deduction of the wage withholding tax, which is equivalent to assuming that someone does not file an income tax report. This procedure takes into account the provisional allowance and the allowance for professional expenses, assuming that actual expenses do not exceed these lump sum allowances. It seems plausible that high-school graduates, who are usually unmarried and in most cases do not yet have children, make similar simplifying assumptions when they calculate their future taxes and social security contributions.

5 Estimation Results of the Enrollment Decision Model

Table 1 provides the estimation results of the structural enrollment decision model. The four columns provide the results from different specifications of the discount parameter γ, which is set at 1.02, 1.05, 1.08, and 1.1, respectively. In general, the results are not sensitive to the choice of γ.

The point estimate for the structural parameter of constant relative risk aversion ρ is approximately 0.1 for all γ. It is significant at the 10% level except for $\gamma = 1.02$. The positive ρ indicates risk-averse agents, though the degree of risk aversion is low. Holt and Laury (2002) estimate a higher degree of risk aversion, that is, around 0.3-0.5. The agents in our sample may be less risk averse than the population at large because of their particularly young age at the time of their decision about university enrollment; Dohmen et al. (forthcoming) provide some evidence that risk aversion increases with age.

Table 1: Transition to Tertiary Education

	$\gamma = 1.02$ Coef.	$\gamma = 1.05$ Coef.	$\gamma = 1.08$ Coef.	$\gamma = 1.10$ Coef.
Eligible for student aid	-0.428*	-0.431*	-0.435*	-0.437*
	(0.174)	(0.175)	(0.175)	(0.174)
Mother has university degree	0.591**	0.593**	0.593**	0.592**
	(0.178)	(0.178)	(0.178)	(0.178)
Father has university degree	0.127	0.127	0.128	0.129
	(0.168)	(0.168)	(0.168)	(0.168)
Parental net income (in 1000 EUR)	0.021	0.021	0.021	0.021
	(0.043)	(0.043)	(0.043)	(0.043)
Male	-1.030**	-0.985**	-0.936**	-0.908**
	(0.242)	(0.242)	(0.242)	(0.243)
Baseline hazard: time since high-school graduation				
(Base: up to one year)				
Two years	-0.401	-0.419	-0.429	-0.432
	(0.263)	(0.264)	(0.264)	(0.264)
Three years	-0.040	-0.057	-0.063	-0.066
	(0.347)	(0.347)	(0.348)	(0.348)
Four years	0.789*	0.775*	0.773*	0.770*
	(0.385)	(0.384)	(0.384)	(0.384)
Five years	0.272	0.265	0.277	0.287
	(0.439)	(0.438)	(0.437)	(0.437)
Two years x male	2.311**	2.308**	2.307**	2.308**
	(0.367)	(0.367)	(0.367)	(0.367)
Three years x male	1.360**	1.327**	1.300**	1.289**
	(0.439)	(0.440)	(0.441)	(0.442)
Four years x male	0.897†	0.832†	0.776	0.748
	(0.478)	(0.478)	(0.478)	(0.478)
Five years x male	1.817**	1.740**	1.667**	1.626**
	(0.517)	(0.516)	(0.515)	(0.514)
Constant	-7.953	-7.814	-8.083	-8.405
	(15.819)	(15.802)	(15.808)	(15.826)
ρ	0.099	0.099†	0.099†	0.100†
	(0.063)	(0.060)	(0.056)	(0.054)
α	0.010**	0.016**	0.023**	0.029**
	(0.002)	(0.003)	(0.005)	(0.006)
Observations	1144	1144	1144	1144
Average probability	0.351	0.351	0.351	0.351

Significance levels: † : 10% $*$: 5% $**$: 1%

Notes: Robust standard errors are in parentheses

Other control variables are year dummies, regional dummies, most recent grades in math and German, one sibling, more siblings, and highest intended degree at age 17. See Table B6.

The parameter of risk-adjusted income α is positive and significant at the 1% level. As expected, higher risk-adjusted returns from an academic career path in comparison with a non-academic career path increase the probability of university enrollment.

The coefficient of the dummy variable regarding the student aid eligibility of the high-school graduate ("Eligible for student aid") is significant and negative. The coefficients for parental education and parental net income are positive, but only the education of the mother is significantly different from zero. All these variables capture the social background of a person and are hard to interpret separately. Student aid eligibility depends mostly on parental income and wealth, which in turn is highly correlated with education. Together, the results indicate that children from a socially disadvantaged background (i.e., eligible for student aid, low parental income and education) are less likely to enroll at a university. This assertion is consistent with the existence of credit constraints, but it could also indicate that better educated and richer parents are able to provide more immaterial support, encouragement, and insurance to their children.

Gender differences are captured by the "male" dummy, as well as its interaction with the dummy variables indicating the time elapsed since high-school graduation. The results show that men exhibit a lower enrollment probability in the first year after high-school graduation but a higher one in the following years, which reflects that German young men often serve a mandatory military or alternative civil service term immediately after their high-school graduation.

The estimated coefficients of the additional control variables, in Table B6, indicate that good grades at the age of 17 years have a positive effect on the probability of university enrollment. The same holds for the variable indicatig if a future high-school graduate had the intention at the age of 17 years to obtain a university degree in the future. This variable might capture preferences for certain career choices that form at an earlier age.

Because our estimates are not sensitive to the choice of γ, in the following we focus on the estimates derived using the specification for which γ is 1.05. We conducted all the calculations and simulations for the other choices of γ as well and consistently find very similar results, which are available from the authors upon request.

At the mean values of the explanatory variables, the estimated hazard of university enrollment for a high-school graduate in the sample in a given year is 35.1%. The cumulative probability of enrollment after five years is estimated to be 70%. These numbers do not significantly differ from official statistics, which report an average yearly university enrollment rate of 37% of a German high-school graduate and reveal that 75% of the graduates enroll within five years of leaving high-school (Statistisches Bundesamt, 2007). Steiner and Wrohlich (2008) estimate very similar probabilities on the basis of a non-structural model of university enrollment, also using SOEP data.

Based on the estimated structural model, we can calculate how much the enrollment probability reacts to a change in the expected value or variance of net wages in the academic or non-academic career path. Table 2 shows the estimated changes in the average and cumulative enrollment probabilities that result from a 10% increase in the respective variables.

Table 2: Induced Changes in University Enrollment

	Average Yearly		Cumulative (after 5 years)	
	in percent	in percentage points	in percent	in percentage points
Increase by ten percent of				
Academic net income	22.957**	6.283**	13.081**	6.721**
	(5.881)	(1.825)	(4.988)	(2.338)
Non academic net income	-12.361**	-3.320**	-8.537**	-4.402**
	(2.637)	(1.006)	(2.593)	(1.385)
Variance academic net income	-0.415**	-0.115**	-0.275**	-0.141**
	(0.096)	(0.034)	(0.090)	(0.046)
Variance non academic net income	0.251**	0.074**	0.155**	0.086**
	(0.058)	(0.022)	(0.053)	(0.028)

Significance levels: † : 10% ∗ : 5% ∗∗ : 1%

The average changes in the yearly enrollment probabilities are calculated by predicting the estimated hazard rate for each observation in the sample before and after changing the income variables. Likewise, the average changes in the cumulative enrollment probabilities (five years after high-school graduation) are calculated after evaluating the cumulative failure function, which is derived from the estimated hazard rate model, for each observation in the sample. Increasing one of the income variables or the variances leads to significant changes in the enrollment probabilities. All reactions have the expected sign, which indicates that higher expected net wages as an academic attract people to enroll in a university, but the higher income variance for academics deters people from doing so. A 10% rise in expected net wages for academics increases the cumulative probability of enrolling by 6.7 percentage points, if the net wages for non-academics and the variance in both career paths do not change. A 10% rise in wages for non-academics decreases the probability by 4.4 percentage points, ceteris paribus. The elasticities are not equal in absolute terms because of the different mean variances in the two career paths. If the wage variance in the academic path increases by 10%, the enrollment probability decreases by 0.14 percentage points, everything else being equal. An increase in the wage variance in the non-academic path leads to an increase in the enrollment probability by 0.09 percentage points.

6 Simulation of Flat-Rate Tax Reform

As shown in the previous section, expectations about future net income influence the university enrollment decision. Therefore the estimated structural model can be applied to simulate the effects of tax policy scenarios on university enrollment. As an illustrative example, we analyze the effects of two revenue-neutral flat-rate tax scenarios. Flat-rate taxes have been widely discussed in Germany; Kirchhoff (2003), Mitschke (2004), and the Council of Economic Advisors to the Ministry of Finance (2004) all have presented proposals for tax policy reforms with (almost) flat-rate schedules.

In the strictest sense, a flat tax is a uniform tax rate on the total tax base. In practice, a flat income tax rate is usually combined with a basic tax allowance, which leads to an implicitly progressive tax schedule. Thus, if the tax base is left unchanged, a flat-rate tax policy can be defined by two parameters, the uniform tax rate and the basic allowance. Fuest et al. (2008) analyze the distributional and labor supply effects of two flat tax scenarios for Germany using a microsimulation model. The first policy is defined by a low tax rate and a low basic allowance (scenario "Low-Low"), whereas the second features higher values for the two parameters (scenario "High-High"). These authors balance the parameters of each scenario to establish revenue neutrality in their simulation for 2007, assuming that there are no behavioral responses such as labor supply reactions. In the scenario "Low-Low" (LL), the basic allowance remains unchanged at 7,664 EUR, and the tax rate that establishes revenue neutrality is 26.9%. In the scenario "High-High" (HH), a higher basic allowance of 10,700 EUR and a higher revenue neutral flat tax rate of

31.9% are chosen.[13] Scenario HH is implicitly more progressive than scenario LL because of its high basic allowance. Thus, it is more similar to Germany's current progressive tax schedule, whereas in scenario LL effective tax rates are significantly flatter.

The aim of this section is to estimate the effects of the two flat tax policies defined by Fuest et al. (2008) on university enrollment. The baseline scenario is the actual German tax legislation of 2005 and 2006.[14] Correspondingly, we use the high-school graduates observed in 2005 or 2006 to simulate the effects of the reforms. Using our microsimulation model, we calculate the first and second moment of net (after-tax) income in the baseline and the two alternative policy scenarios, based on our estimates of gross income, and then apply the estimated structural model of university enrollment to simulate the effects of the changes in the expectation and variance of net income.

The results are presented in Table 3 along with the tax parameters that define the scenarios. In the baseline scenario (first row), the average yearly probability of university enrollment is estimated to be 32.0% for female and 31.6% for male high-school graduates.[15] The model accounts for gender differences by employing gender-specific baseline hazards, and the other explanatory variables control for different endowments.

We focus on the simulation results for the flat tax scenario LL first, which leaves the basic tax allowance unchanged. The results indicate that scenario LL makes university education more attractive for male high-school graduates. The average yearly probability of enrollment for young men significantly increases from 31.6% to 33.1% (+1.4 percentage points). The cumulative probability of enrollment five years after high-school graduation also increases significantly by 1.8 percentage points, which corresponds to a relative in-

[13] The distinctive feature of scenario HH is that it does not change the Gini index of inequality compared with a situation without the reform, according to the simulations of Fuest et al. (2008), again without behavioral responses. This is explained by the high basic allowance, which reduces taxes for low income people. The Council of Economic Advisors to the Ministry of Finance (2004) suggested a similar (but not revenue-neutral) flat tax with a basic allowance of 10,000 EUR and a tax rate of 30%.

[14] This is after the full implementation of the Tax Reform 2000, which reduced the general statutory income tax rates and simultaneously increased the basic tax allowance in three steps between 1 January 2001 and 1 January 2005. The top marginal income tax rate dropped from 51% in 2000 to 42% in 2005, the lowest marginal tax rate from 22.9% to 15%, and the basic allowance increased from 6,902 EUR to 7,664 EUR (for an unmarried individual); see also Fossen (2009).

[15] This estimate, which is based on the pooled sample of 2005 and 2006, is somewhat lower than the estimate based on 2002-2006, which was reported in section 5.

crease in the cumulative enrollment probability by 3.1%. The change in the cumulative probability is directly relevant to policy, because it indicates how much the share of men who decide to study at all would increase (very few people enter university later than after five years after their high-school graduation).

Table 3: Simulated Changes in the Probability of University Enrollment

	Male High-School Graduates		Female High-School Graduates		Tax Parameters	
	Average Probability (yearly)	Cumulative Probability (after 5 years)	Average Probability (yearly)	Cumulative Probability (after 5 years)	Basic Allowance (EUR)	Marginal Tax Rate[1] (percent)
Baseline Scenario						
Enrollment Probability	31.635**	58.880**	31.952**	75.092**	7,664	15-42
	(8.788)	(12.020)	(9.072)	(9.585)		
Low-Low						
Enrollment Probability	33.078**	60.728**	31.118**	74.543**	7,664	26.9
	(9.010)	(11.889)	(8.964)	(9.800)		
Difference in percentage points (effect of reform)	1.443*	1.848*	-0.835**	-0.549		
	(0.612)	(0.875)	(0.323)	(0.401)		
High-High						
Enrollment Probability	31.281**	58.400**	31.523**	74.548**	10,700	31.9
	(8.734)	(12.047)	(8.978)	(9.662)		
Difference in percentage points (effect of reform)	-0.354	-0.480	-0.430*	-0.544*		
	(0.238)	(0.343)	(0.199)	(0.262)		

Significance levels: † : 10% $*$: 5% $**$: 1%
Standard errors in parentheses
[1] plus solidarity surcharge in all scenarios

The simulated effect of scenario LL on young men contrasts with the effect on young women. The flat tax scenario significantly decreases womens' average yearly probability of university enrollment by 0.8 percentage points. There is no significant effect on the female cumulative enrollment probability, however. Scenario LL may thus induce female high-school graduates to enter university less quickly, but would not significantly decrease the number of female university students in the long run.

What explains the different effects of the flat tax scenario on male and female high-school graduates? The revenue-neutral flat tax reform has two opposing effects. First, the tax burden decreases for higher and increases for lower incomes (above the allowance), so an academic career path becomes more attractive (incentive effect of taxation). Second, the variance of net income increases with a flat tax, which is especially relevant for academics, who face higher income risk. This effect discourages potential students from an academic career, as it becomes more risky (risk-sharing aspect of progressive taxation). The simulation results indicate that for men, the positive incentive effect of the flat tax outweighs the negative risk-sharing effect. For women, it is the other way round. This is explained by men's higher wages, especially in the academic career path. The spread between academic and non-academic average predicted gross wages is 9.11 EUR for men but only 5.93 EUR for women (see the bottom of Table B4). Because the flat tax reduces the tax rates for higher incomes, for men, incentives for an academic versus a non-academic path increase more than for women. In contrast, the spread between the log(variance) of gross wages in the alternative career paths is 0.89 for women and only 0.76 for men (Table B5). The flat tax increases the variance of net wages, and this discouraging effect is stronger for women.

Scenario HH combines a flat tax rate with a basic tax allowance that is almost 40% higher than in the baseline scenario. It thus not only decreases the tax burden for high income people, but also for low income people who benefit from the higher allowance. As the reform scenario is revenue-neutral, people at intermediate income ranges pay more taxes than in the baseline scenario. The simulation results indicate that scenario HH has no significant effect on young men's university enrollment, whereas for young women, enrollment decreases somewhat, and the decrease is statistically significant. The average yearly enrollment probability of female high-school graduates decreases by 0.4 percentage points, and the cumulative enrollment probability after five years by 5.4 percentage points, which corresponds to a relative decrease by 0.7%. In this scenario, the disadvantage of the flat tax in terms of higher income risk offsets or even outweighs the incentive effect. Especially for women, who have lower wages than men, the high basic tax allowance in this scenario makes the non-academic career path relatively more attractive. The different results for the two flat tax scenarios highlight the importance of clear definitions when talking about a flat tax.

To illustrate the simulation results, we use Figure 1 to depict the development of the cumulative enrollment probabilities in the different tax scenarios during the first five years after high-school graduation, separately for men and women with average observed characteristics.

7 Conclusion

We estimate a structural microeconometric model of university enrollment, in which high-school graduates decide to enroll according to their comparison of the present value of the discounted utility from career paths with and without a university degree. Utility in each future period depends on not only expected income but also income risk. The expected value and the variance of wages in the two alternative career paths are estimated individually, taking into account non-random selection based on multiple correlated criteria.

The estimation results are consistent with expectations. Higher risk-adjusted expected wages as a university graduate, relative to the alternative, increase the probability of enrollment. The Arrow-Pratt coefficient of constant relative risk aversion, which is included in the structural model as a parameter, is econometrically estimated to be approximately 0.1 and statistically significant. Thus, high-school graduates are risk averse, though to a low degree, potentially because of their young age. Consequently, a higher variance of net wages for academics, ceteris paribus, discourages high-school graduates from pursuing tertiary education.

In contrast to the existing literature considering earnings risk, this analysis acknowledges that after-tax income is relevant for the decision to acquire tertiary education and takes taxation explicitly into account. Both the incentive effect of taxation – through its impact on the earnings differential between academic and non-academic career paths – and the risk-sharing effect – through its impact on earnings risk in the two alternatives – can be analyzed simultaneously. This method allows us to apply the estimated structural model to simulate the effect of tax policy reforms on university enrollment.

We apply the estimated model to simulate the effects of two hypothetical revenue-neutral, flat-rate tax scenarios on university enrollment in Germany. The simulation results indicate that a revenue-neutral, flat tax scenario with an unchanged basic tax allowance would significantly increase the cumulative probability of university enrollment for male high-school graduates by 1.8 percentage points (five years after high-school graduation), which corresponds to a relative increase of 3.1%. For men, the positive incentive effect of the flat tax reform thus outweighs the negative insurance effect. Because of women's lower expected wages though, the simulated flat tax scenario with an unchanged basic allowance would not have a significant effect on the cumulative enrollment probability of female high-school graduates.

The policy debate about taxation and tertiary education focuses primarily on the effect of relative levels of net income on incentives for education. However, the findings from this study suggest that it may be just as important to consider the relative after-tax income risk associated with academic and non-academic career paths.

References

Anderberg, D. (2009): "Optimal policy and the risk properties of human capital reconsidered". Journal of Public Economics, 93:1017–1026.

Anderberg, D. and Andersson, F. (2003): "Investments in human capital, wage uncertainty, and public policy". Journal of Public Economics, 87:1521–1537.

Belzil, C. and Hansen, J. (2004): "Earnings Dispersion, Risk Aversion and Education". Working Papers 0406, Groupe d'Analyse et de Thorie Economique (GATE), Centre national de la recherche scientifique (CNRS), Universit Lyon 2, Ecole Normale Suprieure.

Brodaty, T., Gary-Bobo, R.J., and Prieto, A. (2006): "Risk Aversion and Human Capital Investment: A Structural Econometric Model". CEPR Discussion Papers 5694, C.E.P.R. Discussion Papers.

Carneiro, P., Hansen, K., and Heckman, J. (2003): "Estimating distributions of treatment effects with an application to the returns to schooling and measurement of the effects of uncertainty on college choice". International Economic Review, 44(2):361–422.

Carneiro, P. and Heckman, J.J. (2002): "The Evidence on Credit Constraints in Post-Secondary Schooling". The Economic Journal, 112(482):705–734.

Council of Economic Advisors to the Ministry of Finance (2004): "Flat Tax oder Duale Einkommensteuer? Zwei Entwürfe zur Reform der deutschen Einkommensbesteuerung".

Cunha, F., Heckman, J., and Navarro, S. (2005): "Separating uncertainty from heterogeneity in life cycle earnings". Oxford Economic Papers, 57(2):191–261.

Cunha, F. and Heckman, J.J. (2007): "Identifying and Estimating the Distributions of Ex Post and Ex Ante Returns to Schooling". Labour Economics, 14(6):870–893. Education and Risk - Education and Risk S.I.

Deutscher Bundestag (2007): "Siebzehnter Bericht nach 35 des Bundesausbildungsförderungsgesetztes zur Überprüfung der Bedarfssätze, Freibeträge sowie Vomhundertsätze und Höchstbeträge nach 21 Abs.2." Deutscher Bundestag, Drucksache 16/4123.

Dohmen, T., Falk, A., Huffman, D., Schupp, J., Sunde, U., and Wagner, G.G. (forthcoming): "Individual Risk Attitudes: Measurement, Determinants and Behavioral Consequences". Forthcoming in: Journal of the European Economic Association.

Eaton, J. and Rosen, H. (1980): "Taxation, human capital and uncertainty". American Economic Review, 70(4):705–715.

Fishe, R.P., Trost, R., and Lurie, P.M. (1981): "Labor Force Earnings and College Choice of Young Women: An Exammination of Selectivity Bias and Comparative Advantage". Economics of Education Review, 1(2):169–191.

Fossen, F.M. (2009): "Would a Flat-Rate Tax Stimulate Entrepreneurship in Germany? A Behavioural Microsimulation Analysis Allowing for Risk". Fiscal Studies, 30(2):179–218.

Fuest, C., Peichl, A., and Schaefer, T. (2008): "Is a Flat Tax Reform Feasible in a Grown-up Democracy of Western Europe? A Simulation Study for Germany". International Tax and Public Finance, 15(5):620–636.

Glocker, D. (2009): "The Effect of Student Aid on the Duration of Study". DIW Discussion Paper 893, German Institute for Economic Research.

Hartog, J. and Serrano, L.D. (2007): "Earnings Risk and Demand for Higher Education: A Cross-Section Test for Spain". Journal of Applied Economics, X(1):1–28.

Hartog, J. and Vijverberg, W.P. (2007): "On compensation for risk aversion and skewness affection in wages". Labour Economics, 14(6):938–956.

Heckman, J.J. (1978): "Dummy Endogenous Variables in a Simultaneous Equation System". Econometrica, 46(4):931–59.

Heckman, J.J., Lochner, L., and Taber, C. (1998): "Tax Policy and Human-Capital Formation". American Economic Review, 88(2):293–97.

Heine, C., Spangenberg, H., and Willich, J. (2008): "Studienberechtigte 2006 ein halbes Jahr nach Schulabschluss - bergang in Studium, Beruf und Ausbildung". HIS: Forum Hochschule.

Heublein, U., Spangenberg, H., and Sommer, D. (2003): "Ursachen des Studienabbruchs-Analyse 2002". Technical report, HIS.

Hogan, V. and Walker, I. (2003): "Education Choice under Uncertainty and Public Policy". Working Papers 200302, School Of Economics, University College Dublin.

Holt, C.A. and Laury, S.K. (2002): "Risk Aversion and Incentive Effects". The American Economic Review, 92(5):1644–1655.

Hummel, M. and Reinberg, A. (2007): "Qualifikationsspezifische Arbeitslosigkeit im Jahr 2005 und die Einfhrung der Hartz-IV-Reform - Empirische Befunde und methodische Probleme". IAB Forschungsbericht.

Kane, T.J. (2003): "A Quasi-Experimental Estimate of the Impact of Financial Aid on College-Going". Working Paper Series 9703, NBER Working Paper.

Keane, M.P. and Wolpin, K.I. (2001): "The Effect of Parental Transfers and Borrowing Constraints on Educational Attainment". International Economic Review, 42(4):1051–1103.

Kirchhoff, P. (2003): Einkommensteuergesetzbuch Ein Vorschlag zur Reform der Einkommen− und Körperschaftsteuer. C. F. Müller Verlag, Heidelberg.

Kodde, D. (1986): "Uncertainty and the demand for education". Review of Economics and Statistics, 68:460–467.

Levhari, D. and Weiss, Y. (1974): "The Effect of Risk on the Investment in Human Capital". American Economic Review, 64(6):950–63.

Maddala, G.S. (1986): Limited-dependent and qualitative variables in econometrics. Number 3 in Econometric Society Monographs. Cambridge University Press.

McFadden, D. (1974): "Conditional Logit Analysis of Qualitative Choice Behavior". In P. Zarembka, editor, "Frontiers in Econometrics", pages 105–142. Academic Press, New York.

Mitschke, J. (2004): Erneuerung des deutschen Einkommensteuerrechts: Gesetzestextentwurf und Begründung. Verlag Otto Schmidt, Cologne.

OECD (2008): Education at a glance 2008. OECD, Paris.

Pratt, J.W. (1964): "Risk Aversion in the Small and in the Large". Econometrica, 32(1/2):122–136.

Rosenbaum, S. (1961): "Moments of a Truncated Bivariate Normal Distribution". Journal of the Royal Statistical Society. Series B (Methodological), 23(2):405–408.

Sauer, R.M. (2004): "Educational Financing and Lifetime Earnings". Review of Economic Studies, 71(4):1189–1216.

Shea, J. (2000): "Does parents' money matter?" Journal of Public Economics, 77(2):155–184.

Statistisches Bundesamt (2007): Hochschulen auf einen Blick. Wiesbaden.

Steiner, V., Geyer, J., Haan, P., and Wrohlich, K. (2008): "Documentation of the Tax-Benefit Microsimulation Model STSM: Version 2008". DIW Data Documentation 31, German Institute for Economic Research.

Steiner, V. and Wrohlich, K. (2008): "Financial Student Aid and Enrollment into Higher Education: New Evidence from Germany". DIW Discussion Paper 805, German Institute for Economic Research.

Wagner, G.G., Frick, J.R., and Schupp, J. (2007): "The German Socio-Economic Panel Study (SOEP) - Scope, Evolution and Enhancements". Schmollers Jahrbuch, 127(1):139–169.

Willis, R.J. and Rosen, S. (1979): "Education and Self-Selection". The Journal of Political Economy, 87(5):S7–S36.

A Technical Appendix: Multiple Criteria Selection Model

Starting from the wage equations (17), and disregarding the selection correction and explicitly separating the equations by academics and non-academics, we obtain (time indices are neglected)

$$\begin{aligned} y^g_{1i} &= \theta_1' z_i^{wage} + u_{1i}, \; and \\ y^g_{2i} &= \theta_2' z_i^{wage} + u_{2i}, \end{aligned} \tag{19}$$

where a person earns wage y_{1i} if she has a university degree and is working:

$$y_{1i} = \begin{cases} 0 & \text{if } I^*_{1i} > 0, \quad I^*_{2i} < 0, \\ y^* & \text{if } I^*_{1i} > 0, \quad I^*_{2i} > 0, \end{cases} \tag{20}$$

whereas a person who has no university degree and is working is observed with wage y_{2i}

$$y_{2i} = \begin{cases} 0 & \text{if } I^*_{1i} \leq 0, \quad I^*_{2i} < 0, \\ y^* & \text{if } I^*_{1i} \leq 0, \quad I^*_{2i} > 0. \end{cases} \tag{21}$$

When incorporating the selection process, which is described by equations (13) and (15), into the wage equations (19), we derive the following conditional expected wages:

$$\begin{aligned} E(y_{1i}|I^*_{1i} > 0, I^*_{2i} > 0) &= E(y_{1i}|v_{1i} > -z_{1i}\eta_1, v_{2i} > -(z_{2i}\eta_2 + I_1\iota)) \\ &= \theta_1' z_i^{wage} + E(u_{1i}|\epsilon_1 > -z_{1i}\eta_1, v_{2i} > -(z_{2i}\eta_2 + I_1\iota)). \\ E(y_{2i}|I^*_{1i} \leq 0, I^*_{2i} > 0) &= E(y_{2i}|v_{1i} < -z_{1i}\eta_1, v_{2i} > -(z_{2i}\eta_2 + I_1\iota)) \\ &= \theta_2' z_i^{wage} + E(u_{2i}|v_{1i} < -z_{1i}\eta_1, v_{2i} > -(z_{2i}\eta_2 + I_1\iota)). \end{aligned} \tag{22}$$

The two decisions – to obtain a university degree and working – are allowed to be correlated. The correlation is reflected in the error terms ($cov(v_1, v_2) = \rho_{v_1 v_2} \neq 0$). The error terms are assumed to have a normal distribution with zero mean and $var(v_1) = var(v_2) = 1$ (in addition, person indices will be neglected in the following),

$$\begin{pmatrix} u_1 \\ u_2 \\ v_1 \\ v_2 \end{pmatrix} \sim N\left(0, \begin{pmatrix} \sum uu & \sum uv \\ \sum vu & \sum vv \end{pmatrix}\right)$$

Following Maddala (1986), the second term on the right-hand side of equation (22) can be expressed as:

$$\begin{aligned} E(u_1 | v_1 > -z_1\eta_1, v_2 > -(z_2\eta_2 + I_1\iota)) &= \lambda_{11}M_{12} + \lambda_{12}M_{21} \\ E(u_2 | v_1 < -z_1\eta_1, v_2 > -(z_2\eta_2 + I_1\iota)) &= \lambda_{21}M_{34} + \lambda_{22}M_{43}, \end{aligned} \tag{23}$$

where

$$\begin{aligned} \lambda_{sj} &= cov(u_s, v_j) \\ cov(v_1, v_2) &= \rho \\ M_{ab} &= (1-\rho^2)^{-1}(P_a - \rho P_b) \\ \text{with } a, b = 1, 2 \qquad \text{and } a &\neq b \\ M_{cd} &= (1-\rho^2)^{-1}(P_c - \rho P_d) \\ \text{with } c, d = 3, 4 \qquad \text{and } c &\neq d \end{aligned}$$

with

$$
\begin{aligned}
P_1 &= \frac{\int_{-(z_2\eta_2+I_1\iota)}^{\infty}\int_{-z_1\eta_1}^{\infty} v_1 f(v_1 v_2) dv_1 dv_2}{F(-z_1\eta_1, -(z_2\eta_2+I_1\iota), \rho)} \\
P_2 &= \frac{\int_{-z_1\eta_1}^{\infty}\int_{-(z_2\eta_2+I_1\iota)}^{\infty} v_2 f(v_1 v_2) dv_2 dv_1}{F(-z_1\eta_1, -(z_2\eta_2+I_1\iota), \rho)} \\
P_3 &= \frac{\int_{-(z_2\eta_2+I_1\iota)}^{\infty}\int_{-\infty}^{-z_1\eta_1} v_1 f(v_1 v_2) dv_1 dv_2}{F(z_1\eta_1, -(z_2\eta_2+I_1\iota), -\rho)} \\
P_4 &= \frac{\int_{-\infty}^{-z_1\eta_1}\int_{-(z_2\eta_2+I_1\iota)}^{\infty} v_2 f(v_1 v_2) dv_2 dv_1}{F(z_1\eta_1, -(z_2\eta_2+I_1\iota), -\rho)}
\end{aligned}
$$

According to Rosenbaum (1961) the truncated bivariate normal distribution can be solved numerically, which leads to:

$$
\begin{aligned}
M_{12} &= \frac{\phi(z_1\eta_1)\Phi\left(\frac{(z_2\eta_2+I_1\iota)-\rho(z_1\eta_1)}{\sqrt{1-\rho^2}}\right)}{\Phi_2(z_1\eta_1, z_2\eta_2+I_1\iota, \rho)} \\
M_{21} &= \frac{\phi(z_2\eta_2+I_1\iota)\Phi\left(\frac{z_1\eta_1-\rho(z_2\eta_2+I_1\iota)}{\sqrt{1-\rho^2}}\right)}{\Phi_2(z_1\eta_1, z_2\eta_2+I_1\iota, \rho)} \\
M_{34} &= \frac{\phi(-z_1\eta_1)\Phi\left(\frac{(z_2\eta_2+I_1\iota)-\rho(-z_1\eta_1)}{\sqrt{1-\rho^2}}\right)}{\Phi_2(-z_1\eta_1, z_2\eta_2+I_1\iota, -\rho)} \\
M_{43} &= \frac{\phi(z_2\eta_2+I_1\iota)\Phi\left(\frac{-z_1\eta_1-\rho(z_2\eta_2+I_1\iota)}{\sqrt{1-\rho^2}}\right)}{\Phi_2(-z_1\eta_1, z_2\eta_2+I_1\iota, -\rho)}
\end{aligned}
$$

where ϕ is the standard normal density function, Φ denotes the standard, and Φ_2 is the bivariate normal cumulative distribution. Controlling for the selection terms, the wage equations can now be expressed in the form of equation (17).

B Additional Tables

Table B1: Descriptive Statistics, High-school Graduates

Variable Names	Mean	Standard Dev.
Eligible for student aid	0.36	0.48
Age when finished high school	19.42	1.01
Mother holds university degree	0.27	0.44
Father holds university degree	0.40	0.49
Parental net income (in 1000 EUR)	2.75	1.83
Intended a university degree at age 17	0.27	0.44
Intended degree at age 17 n.a.	0.59	0.49
Respondent has one sibling	0.32	0.47
Respondent has more than one sibling	0.09	0.28
Finished apprenticeship	0.13	0.33
Male	0.49	0.50
School grades in German at age 17		
n.a.	0.36	0.48
Very good (1)	0.03	0.17
Good (2))	0.27	0.44
Satisfactory (3)	0.26	0.44
Poor (4-6)	0.08	0.27
School grades in math at age 17		
n.a.	0.36	0.48
Very good (1)	0.06	0.25
Good (2)	0.20	0.40
Satisfactory (3)	0.22	0.41
Poor (4-6)	0.15	0.36
Years since high-school graduation		
One year	0.42	0.49
Two years	0.24	0.43
Three years	0.16	0.36
Four years	0.11	0.32
Five years	0.08	0.27
Observations	1144	

Table B2: Descriptive Statistics, Full Sample

	Men		Women	
Variable Names	Mean	Standard Dev.	Mean	Standard Dev.
Parental education				
High-school degree	0.40	0.49	0.42	0.49
n.a.	0.03	0.18	0.04	0.20
Last grade in subject German				
Very good (1)	0.05	0.22	0.09	0.28
Good (2)	0.20	0.40	0.26	0.44
Satisfactory (3)	0.19	0.39	0.15	0.35
Poor (4-6)	0.05	0.22	0.02	0.14
n.a.	0.50	0.50	0.49	0.50
Last grade in subject math				
Very good (1)	0.10	0.30	0.08	0.27
Good (2)	0.19	0.40	0.18	0.39
Satisfactory (3)	0.14	0.34	0.17	0.37
Poor (4-6)	0.08	0.26	0.10	0.30
n.a.	0.49	0.50	0.47	0.50
Parents show(ed) interest in school performance (at age 15)				
Not at all	0.02	0.12	0.02	0.14
Not very much	0.13	0.34	0.16	0.36
Quiet a lot	0.26	0.44	0.25	0.43
Very much	0.11	0.32	0.12	0.33
n.a.	0.48	0.50	0.45	0.50
Place where grew up (at age 15)				
n.a.	0.07	0.26	0.07	0.26
Medium city (20,000-100,000 inh.)	0.19	0.39	0.19	0.39
Small city (5,000-20,000 inh.)	0.22	0.41	0.21	0.41
Countryside (¡5,000 inh)	0.26	0.44	0.27	0.44
Large city (more than 100,000 inhabitants)	0.26	0.44	0.25	0.43
Father working (at age 15)				
Father Working	0.82	0.38	0.82	0.39
n.a.	0.13	0.33	0.14	0.34
Mother working (at age 15)				
Mother Working	0.29	0.45	0.32	0.47
n.a.	0.50	0.50	0.48	0.50
Parental nationality				
German born	0.58	0.49	0.58	0.49
n.a.	0.38	0.48	0.37	0.48
Work experience	15.24	11.26	11.52	9.93
Experienced years of unemployment	0.50	1.24	0.52	1.26
Unemployment rate	12.03	4.68	12.36	4.75
Age	39.79	11.77	37.51	11.39
Married	0.58	0.49	0.56	0.50
Children aged 5 years and under	0.17	0.37	0.18	0.39
Childrend aged 6 to 16 years	0.24	0.43	0.25	0.43
German born	0.94	0.24	0.93	0.26
Disabled	0.04	0.20	0.04	0.19
Further education after high school				
In training (apprenticeship)	0.02	0.15	0.03	0.17
Finished apprenticeship	0.27	0.44	0.24	0.43
Vocational education	0.18	0.38	0.25	0.43
University of applied science (FH)	0.18	0.38	0.14	0.35
University degree	0.56	0.50	0.45	0.50
Self-employed	0.14	0.35	0.08	0.27
Observations	11,206		11,138	

Table B3: 1st Step Bivariate Probit Estimation, SOEP 2002-2007

	Men		Women	
Variables	Academic	Working	Academic	Working
Parental education				
High-school degree	0.063*		0.123**	
	(0.026)		(0.027)	
n.a.	-0.544**		-0.262**	
	(0.076)		(0.071)	
Last grade in subject German				
(Base: Good (2))				
Very good (1)	0.234**		0.375**	
	(0.064)		(0.050)	
Satisfactory (3)	-0.025		-0.155**	
	(0.039)		(0.040)	
Poor (4-6)	-0.217**		-0.604**	
	(0.061)		(0.097)	
n.a.	0.367**		0.037	
	(0.108)		(0.085)	
Last grade in subject math				
(Base: Good (2))				
Very good (1)	0.241**		0.256**	
	(0.050)		(0.053)	
Satisfactory (3)	-0.281**		-0.174**	
	(0.042)		(0.042)	
Poor (4-6)	-0.413**		-0.190**	
	(0.052)		(0.049)	
n.a.	-0.139		-0.219†	
	(0.138)		(0.112)	
Parents show(ed) interest in school performance (at age 15)				
(Base: Very much)				
Not at all	-0.003		-0.128	
	(0.102)		(0.091)	
Not very much	0.137**		0.036	
	(0.049)		(0.047)	
Quiet a lot	-0.020		-0.208**	
	(0.043)		(0.043)	
n.a.	-0.680**		-0.130	
	(0.119)		(0.111)	
Place where grew up (at age 15)				
(Base: Large city (more than 100,000 inh))				
Medium city (20,000-100,000 inh.)	-0.082*		-0.128**	
	(0.036)		(0.037)	
Small city (5,000-20,000 inh.)	-0.040		-0.029	
	(0.035)		(0.036)	
Countryside (¡5,000 inh)	-0.096**		-0.185**	
	(0.034)		(0.034)	
n.a.	0.099†		-0.091	
	(0.055)		(0.056)	
Father working (at age 15)				
(Base: not working)				
Working	0.600**		0.651**	
	(0.063)		(0.068)	
n.a.	0.629**		0.448**	
	(0.073)		(0.077)	
Mother working (at age 15)				
(Base: not working)				
Working	-0.442**		-0.249**	
	(0.036)		(0.037)	
n.a.	-0.470**		-0.371**	
	(0.055)		(0.055)	
Parents nationality				
German born	0.196**		-0.162**	
	(0.067)		(0.060)	
n.a.	0.786**		0.382**	
	(0.072)		(0.066)	
Age		0.321**		0.300**
		(0.012)		(0.010)
Age squared		-0.003**		-0.003**

Continued on next page...

... table B3 continued

Variables	Men Academic	Men Working	Women Academic	Women Working
		(0.000)		(0.000)
Married		0.130*		-0.313**
		(0.051)		(0.038)
Children aged 5 years and under		0.269**		-0.945**
		(0.063)		(0.037)
Childrend aged 6 to 16 years		-0.060		-0.293**
		(0.055)		(0.036)
German born		-0.046		0.123*
		(0.067)		(0.050)
Disabled		-0.179*		-0.114
		(0.076)		(0.071)
Experienced years of ... since first started working				
Unemployment		-0.491**		-0.195**
		(0.024)		(0.024)
Unemployment squared		0.026**		0.002
		(0.003)		(0.004)
Unemployment rate		-0.006		-0.043**
		(0.008)		(0.010)
Regional dummies		YES		YES
Year dummies		YES		YES
Respondent has university degree		-0.329**		0.098
		(0.122)		(0.124)
Constant	-0.198†	-5.157**	-0.257**	-4.717**
	(0.102)	(0.254)	(0.097)	(0.208)
$\rho_{v_1 v_2}$	0.398**		0.0493	
	(0.081)		(0.078)	
Observations	11192		11126	
χ^2	2506.4		2302.8	

Significance levels: † : 10% ∗ : 5% ∗∗ : 1%
Notes: Standard errors are in parentheses
Regional Dummies: North, South, East, Citystate, West (basecategory)

Table B4: 2nd Step Regression of Wages Per Hour, SOEP 2002-2007

	Men		Women	
Variables	**Academic**	**Non-Academic**	**Academic**	**Non-Academic**
Work experience	0.533**	0.327**	0.257*	0.216**
	(0.077)	(0.071)	(0.117)	(0.051)
Work experience squared	-0.007**	$-0.003^{\dagger}$	-0.003	-0.004**
	(0.002)	(0.002)	(0.003)	(0.001)
Education				
(Base: no further education after high-school)				
In training (apprenticeship)	0.000	-5.190**	0.000	-3.830**
	(.)	(0.603)	(.)	(0.361)
Finished apprenticeship	-1.186*	0.072	-0.783	2.134**
	(0.547)	(0.606)	(0.481)	(0.320)
Vocational education	-1.776*	1.633*	-2.499**	1.975**
	(0.874)	(0.727)	(0.450)	(0.375)
German born	3.241**	2.773**	3.096**	1.188**
	(0.904)	(0.602)	(0.997)	(0.398)
Disabled	-1.458	-0.139	0.854	0.623
	(1.441)	(0.594)	(1.423)	(0.557)
Self-employed	4.970**	2.131*	5.508**	3.005**
	(0.888)	(0.933)	(1.163)	(0.975)
Fed. state dummies	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES
Constant	19.951**	11.858**	19.560**	8.930**
	(1.522)	(1.166)	(2.073)	(1.178)
Selection-terms				
M12	-1.115		-3.784**	
	(1.137)		(1.208)	
M21	-15.580**		$-3.249^{\dagger}$	
	(1.384)		(1.802)	
M34		-0.570		0.985
		(0.484)		(0.779)
M43		-2.339**		-1.959**
		(0.467)		(0.554)
Observations	5800	3415	3773	3706
R^2	0.124	0.191	0.0758	0.178
Mean(wage)	24.12	15.01	17.46	11.53

Significance levels: † : 10% $*$: 5% $**$: 1%

Note: Robust standard errors are in parentheses

Table B5: Estimation of Gross Wages Variance, SOEP 2002-2007

	Men		Women	
Variables	**Academic**	**Non-Academic**	**Academic**	**Non-Academic**
Work experience	-0.053**	-0.037*	-0.016	-0.006
	(0.013)	(0.016)	(0.016)	(0.016)
Work experience squared	0.002**	0.001**	0.001†	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Education				
(Base: no further education after high-school)				
In training (apprenticeship)		-1.557**		-1.789**
		(0.187)		(0.158)
Finished apprenticeship	0.002	-0.487**	0.003	-0.328**
	(0.080)	(0.111)	(0.110)	(0.106)
Vocational education	0.288**	-0.298*	0.161	-0.306**
	(0.099)	(0.122)	(0.109)	(0.111)
German born	-0.129	0.624**	0.040	0.312†
	(0.136)	(0.160)	(0.167)	(0.164)
Disabled	0.137	-0.494*	0.361†	-0.139
	(0.160)	(0.221)	(0.199)	(0.247)
Self-employed	1.525**	1.419**	1.899**	1.402**
	(0.078)	(0.116)	(0.091)	(0.149)
Fed. state dummies	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES
Constant	4.117**	2.678**	2.955**	1.785**
	(0.242)	(0.276)	(0.348)	(0.349)
Selection-terms				
M12	-0.410*		0.021	
	(0.174)		(0.186)	
M21	-0.517*		0.068	
	(0.234)		(0.185)	
M34		-0.017		0.499*
		(0.111)		(0.219)
M43		0.019		0.384*
		(0.122)		(0.170)
Observations	5800	3415	3773	3706
R^2	0.109	0.111	0.151	0.084
Mean(log(variance))	3.521	2.763	3.075	2.190

Significance levels: † : 10% $*$: 5% $**$: 1%
Note: Robust standard errors are in parentheses

Table B6: Transition to Tertiary Education: Full Results

	$\gamma = 1.02$ Coef.	$\gamma = 1.05$ Coef.	$\gamma = 1.08$ Coef.	$\gamma = 1.10$ Coef.
Eligible for student aid	-0.428*	-0.431*	-0.435*	-0.437*
	(0.174)	(0.175)	(0.175)	(0.174)
Age when finished highschool	0.108	0.122	0.173	0.221
	(1.627)	(1.625)	(1.625)	(1.627)
Age when finished highschool squared	0.008	0.007	0.006	0.005
	(0.042)	(0.042)	(0.042)	(0.042)
Mother holds university degree	0.591**	0.593**	0.593**	0.592**
	(0.178)	(0.178)	(0.178)	(0.178)
Father holds university degree	0.127	0.127	0.128	0.129
	(0.168)	(0.168)	(0.168)	(0.168)
Parental net income (in 1000 EUR)	0.021	0.021	0.021	0.021
	(0.043)	(0.043)	(0.043)	(0.043)
At age 17 the highest degree intended was				
University degree	0.719**	0.727**	0.735**	0.742**
	(0.271)	(0.271)	(0.270)	(0.269)
n.a.	0.242	0.248	0.254	0.258
	(0.308)	(0.308)	(0.307)	(0.307)
Respondent has one sibling	-0.371*	-0.369*	-0.366*	-0.363*
	(0.163)	(0.163)	(0.163)	(0.162)
Respondent has more than one sibling	0.138	0.139	0.143	0.146
	(0.277)	(0.277)	(0.277)	(0.277)
Finished apprenticeship	0.653†	0.663†	0.646†	0.621†
	(0.354)	(0.357)	(0.356)	(0.354)
School grades in German at age 17 (Base: Good (2))				
n.a.	1.116	1.098	1.074	1.055
	(1.050)	(1.046)	(1.041)	(1.038)
Very good (1)	1.596**	1.590**	1.583**	1.578**
	(0.464)	(0.464)	(0.465)	(0.465)
Satisfactory (3)	-0.112	-0.113	-0.113	-0.114
	(0.203)	(0.203)	(0.203)	(0.203)
Poor (4-6)	-0.271	-0.269	-0.265	-0.260
	(0.334)	(0.334)	(0.334)	(0.334)
School grades in math at age 17 (Base: Good (2))				
n.a.	-0.905	-0.885	-0.857	-0.836
	(1.039)	(1.035)	(1.031)	(1.028)
Very good (1)	0.675*	0.666*	0.655*	0.647*
	(0.326)	(0.326)	(0.326)	(0.326)
Satisfactory (3)	0.179	0.183	0.187	0.190
	(0.225)	(0.225)	(0.225)	(0.225)
Poor (4-6)	-0.471†	-0.463†	-0.455†	-0.449
	(0.276)	(0.276)	(0.276)	(0.276)
Male	-1.030**	-0.985**	-0.936**	-0.908**
	(0.242)	(0.242)	(0.242)	(0.243)
Baseline hazard: time since high-school graduation (Base: up to one year)				
Two years	-0.401	-0.419	-0.429	-0.432
	(0.263)	(0.264)	(0.264)	(0.264)
Three years	-0.040	-0.057	-0.063	-0.066
	(0.347)	(0.347)	(0.348)	(0.348)
Four years	0.789*	0.775*	0.773*	0.770*
	(0.385)	(0.384)	(0.384)	(0.384)
Five years	0.272	0.265	0.277	0.287
	(0.439)	(0.438)	(0.437)	(0.437)
Two years x male	2.311**	2.308**	2.307**	2.308**
	(0.367)	(0.367)	(0.367)	(0.367)
Three years x male	1.360**	1.327**	1.300**	1.289**
	(0.439)	(0.440)	(0.441)	(0.442)
Four years x male	0.897†	0.832†	0.776	0.748
	(0.478)	(0.478)	(0.478)	(0.478)
Five years x male	1.817**	1.740**	1.667**	1.626**
	(0.517)	(0.516)	(0.515)	(0.514)
Regional dummies (Base: West)				
East	0.528*	0.458*	0.378†	0.324

Continued on next page...

... table B6 continued

	$\gamma = 1.02$ Coef.	$\gamma = 1.05$ Coef.	$\gamma = 1.08$ Coef.	$\gamma = 1.10$ Coef.
	(0.209)	(0.206)	(0.203)	(0.201)
South	0.378*	0.386*	0.392*	0.395*
	(0.189)	(0.189)	(0.188)	(0.188)
North	-0.062	-0.081	-0.103	-0.118
	(0.259)	(0.259)	(0.259)	(0.259)
Citystate	0.212	0.196	0.179	0.169
	(0.394)	(0.394)	(0.394)	(0.394)
Year dummies (Base: 2002)				
Year 2003	-0.730**	-0.740**	-0.747**	-0.752**
	(0.212)	(0.212)	(0.212)	(0.212)
Year 2004	-0.433†	-0.433†	-0.434†	-0.436†
	(0.229)	(0.229)	(0.228)	(0.228)
Year 2005	-0.380	-0.392	-0.410†	-0.423†
	(0.247)	(0.246)	(0.246)	(0.245)
Year 2006	-0.430	-0.466†	-0.500†	-0.523†
	(0.271)	(0.270)	(0.269)	(0.268)
Constant	-7.953	-7.814	-8.083	-8.405
	(15.819)	(15.802)	(15.808)	(15.826)
ρ	0.099	0.099†	0.099†	0.100†
	(0.063)	(0.060)	(0.056)	(0.054)
α	0.010**	0.016**	0.023**	0.029**
	(0.002)	(0.003)	(0.005)	(0.006)
Observations	1144	1144	1144	1144
Average probability	0.351	0.351	0.351	0.351

Significance levels: † : 10% ∗ : 5% ∗∗ : 1%

Note: Robust standard errors are in parentheses

Figure 1: Cumulative University Enrollment by Gender